



Far-Forward detectors:

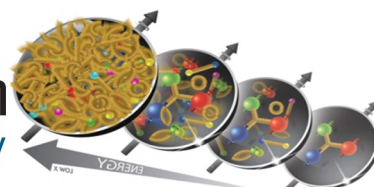
Update on ePIC pixelated AC-LGADs read-out with EICROCO ASIC based on digital data

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06/23/2026

On behalf of all teams involved



Brookhaven
National Laboratory





Pixelated AC-LGAD read-out chip: EICROC

Objective: **Development** and **characterization** of an **ASIC EICROC** (32 x 32) able to read-out the **new generation** of pixelated (500 x 500 μm^2) silicon sensors: **AC-LGAD** (Alternating Current coupled **Low-Gain Avalanche Diode**) for the **Electron Ion Collider** (EIC)

Target: optimized for the ePIC **Roman Pots (RP)**, as first intention (most demanding)

RP AC-LGAD read-out chip requirements:

Pixelated AC-LGADs \leftrightarrow low input capacitance: 2-5 pF


- ❖ **30 ps time resolution**
- ❖ **< 50 μm spatial resolution** exploiting **charge sharing among neighboring pixels**
→ **low charge sensitivity (~3 fC)**
- ❖ **low power consumption (< 1 mW/channel)** as placed inside vacuum
- ❖ **low noise (< 1 mV)**



Stepping up process through successive ASIC iterations to control performances fulfilling ePIC detector requirements

EICROC iterations being designed by 



(contribution from AGH Krakow for  EICROC0 and EICROC1 ADCs)

1st EICROC prototype under test: **EICROC0** (4 x 4 channels)

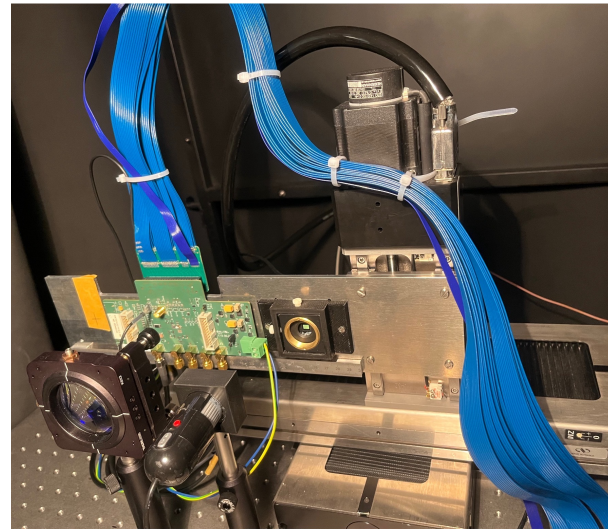
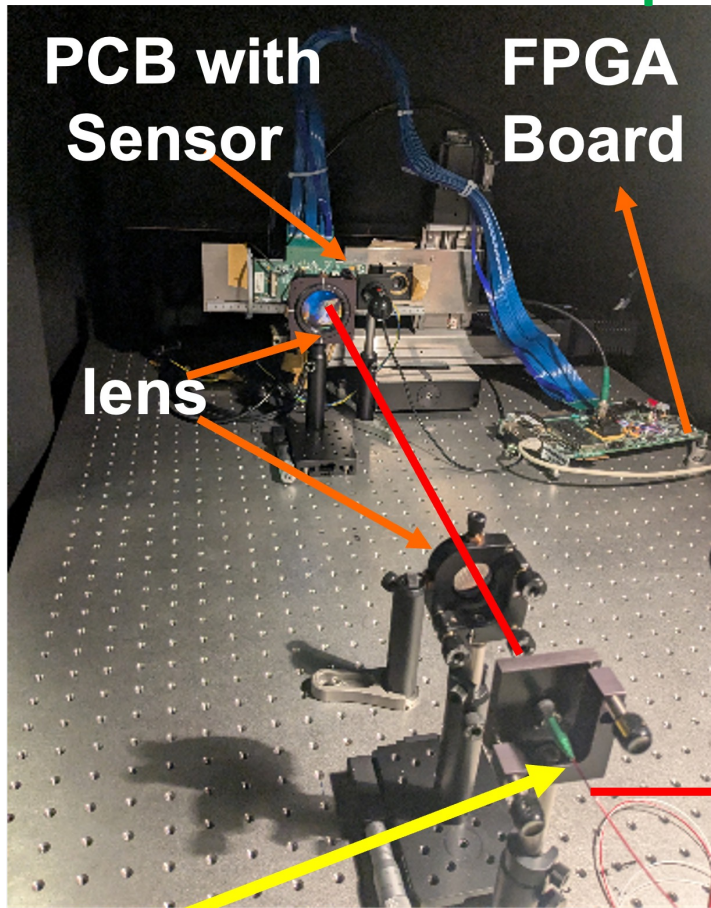
EICROC2 (32x32)

This work is benefitting from support from the French Agence Nationale de la Recherche (ANR), under grant ANR-24-CE31-5571 (project ROAD_4_EIC, 02/2025 – 01/2029)



Pixelated AC-LGAD read-out characterization With Infrared Laser: The setup

Operational since end of Summer 2025

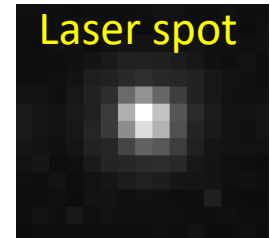


Viewed by a numerical microscope



NKT Photonics Diode Laser

- 1056.4 ± 7.4 nm
- 7 nW av. Power
- 150 mW peak intensity
- 0 – 40 MHz
- 35 ps pulse width (FWHM)
- Jitter RMS = 10.8 ps
- Fiber MFD: $5.3 - 6.4 \mu\text{m}$ @ 980 nm



With CMOS camera

- Clean spot
- $\phi \lesssim 20 \mu\text{m}$ (CMOS pixel = $3.75 \mu\text{m}$)



Pulsed Infrared laser λ 1056 nm

DAC Pulser 63, Vth 380 DACu, cd00

TDC jitter

Raw TDC Distributions – BNL WB “new” – CMD pulse (DAC 63 \approx 25 fC)

TDC distributions

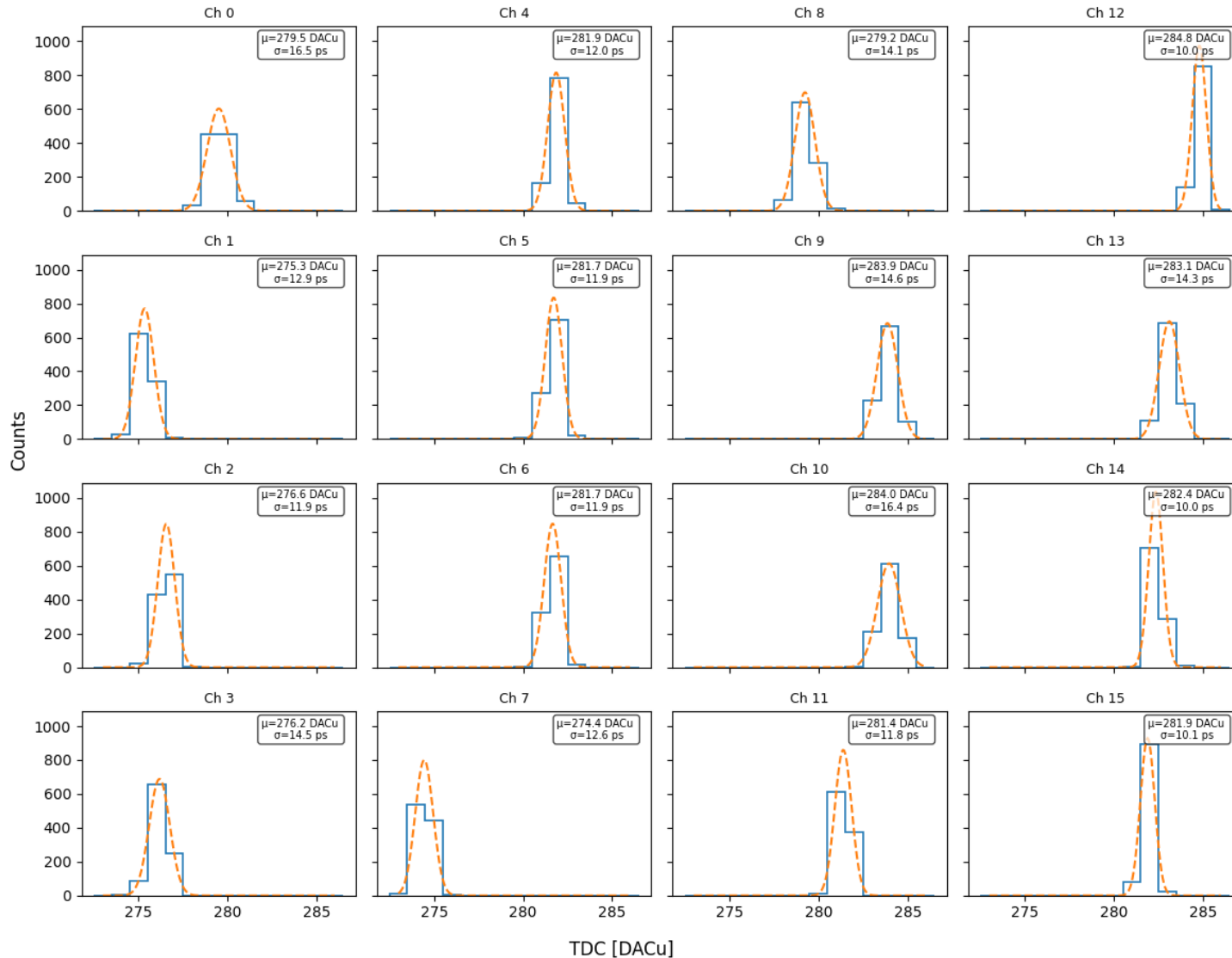
1 000 events / channel

Sensor **NOT BIASED**

TDC 10 bits (1024 values)

TDC LSB: 25 ps

$\sigma \approx 20$ ps



AC-LGAD biased at -158 V

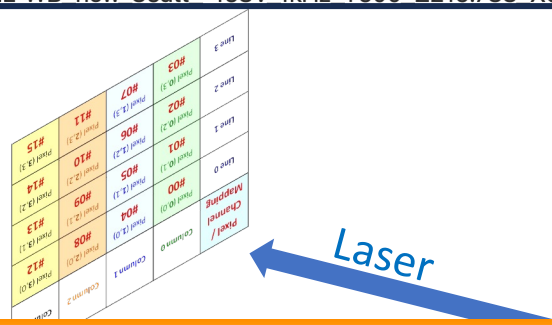
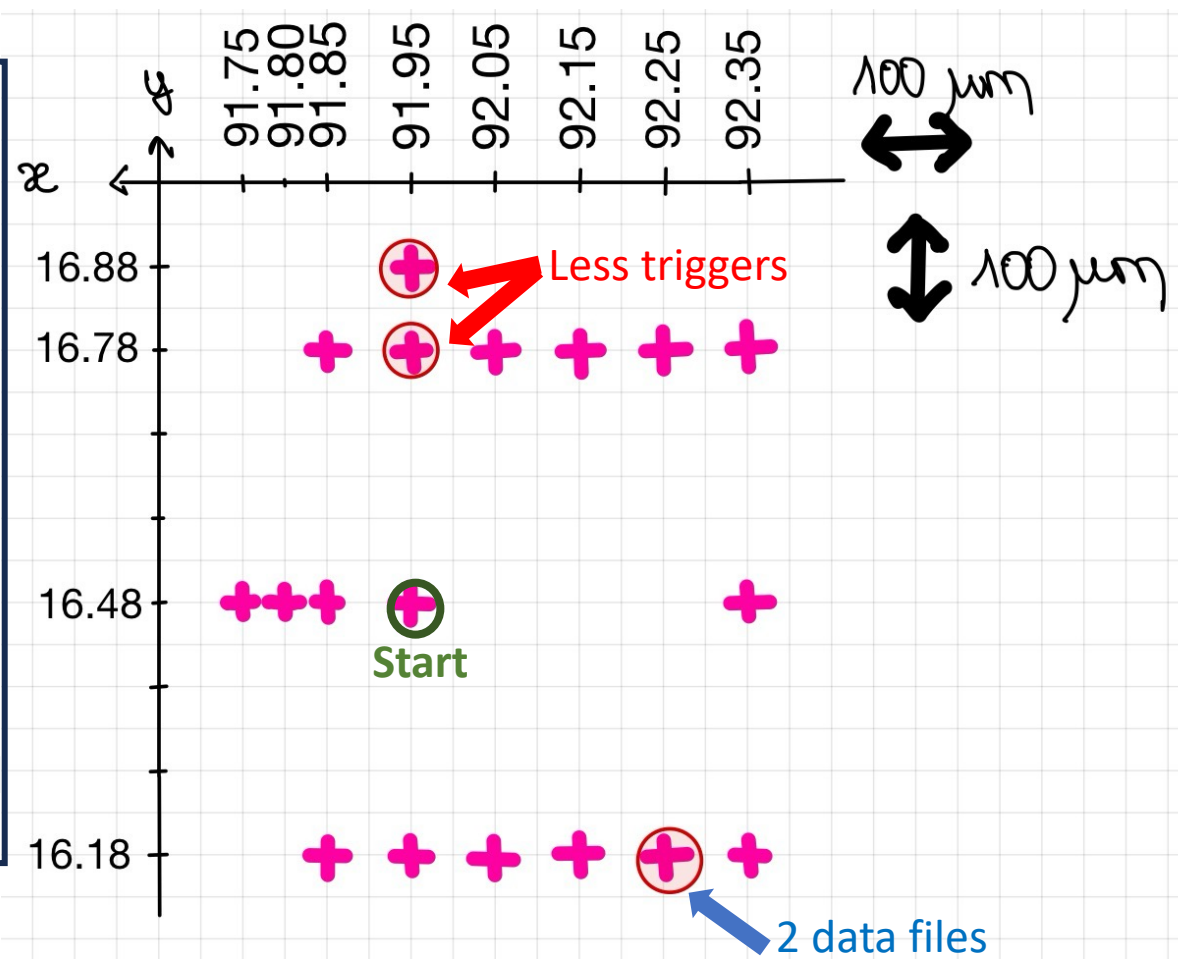
IR laser att 85%, 1 kHz

« Auto-trigger » mode

Vth = 500 DACu

(X,Y) Exploration - April 30th, 2026

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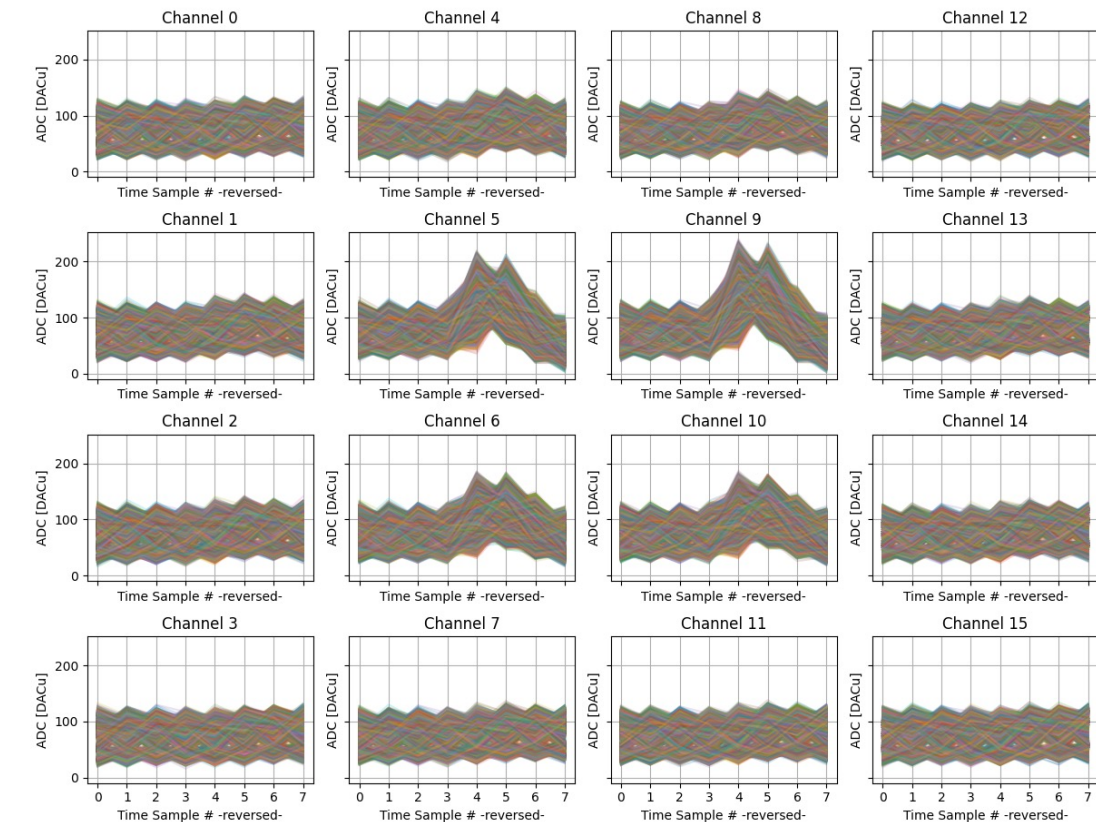
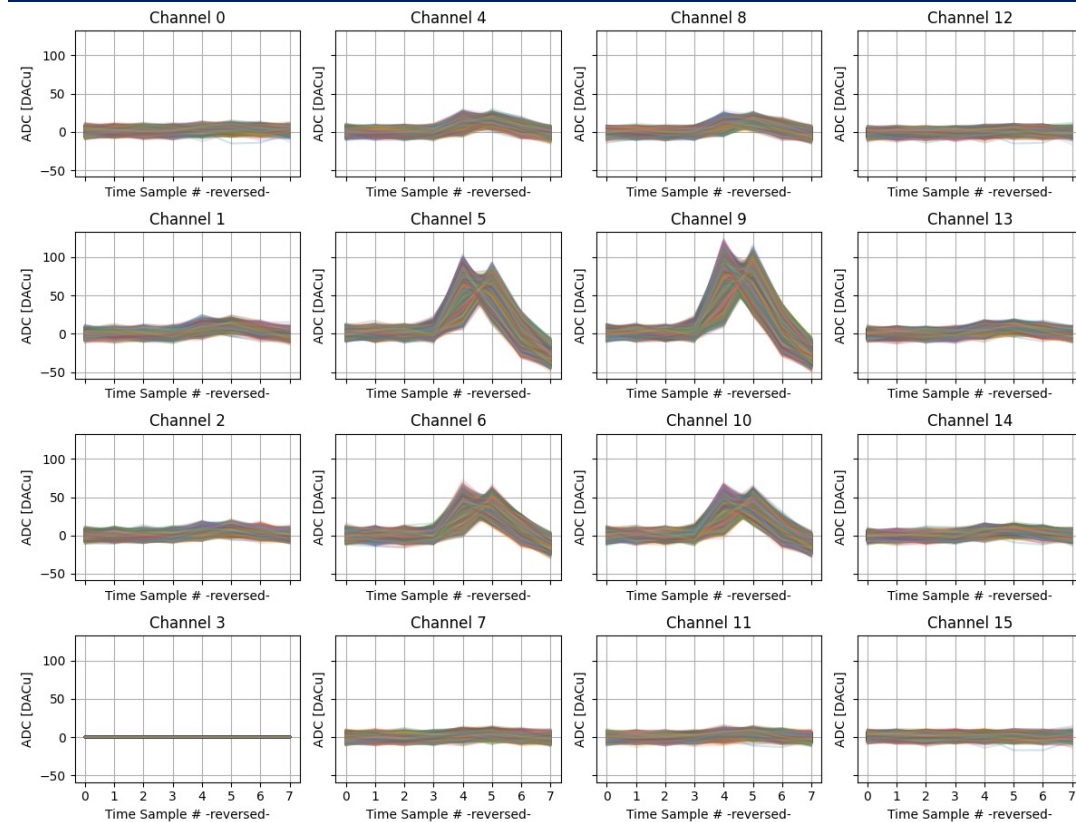
AC-LGAD biased at -158 V

IR laser att 85%, 1 kHz

« Auto-trigger » mode

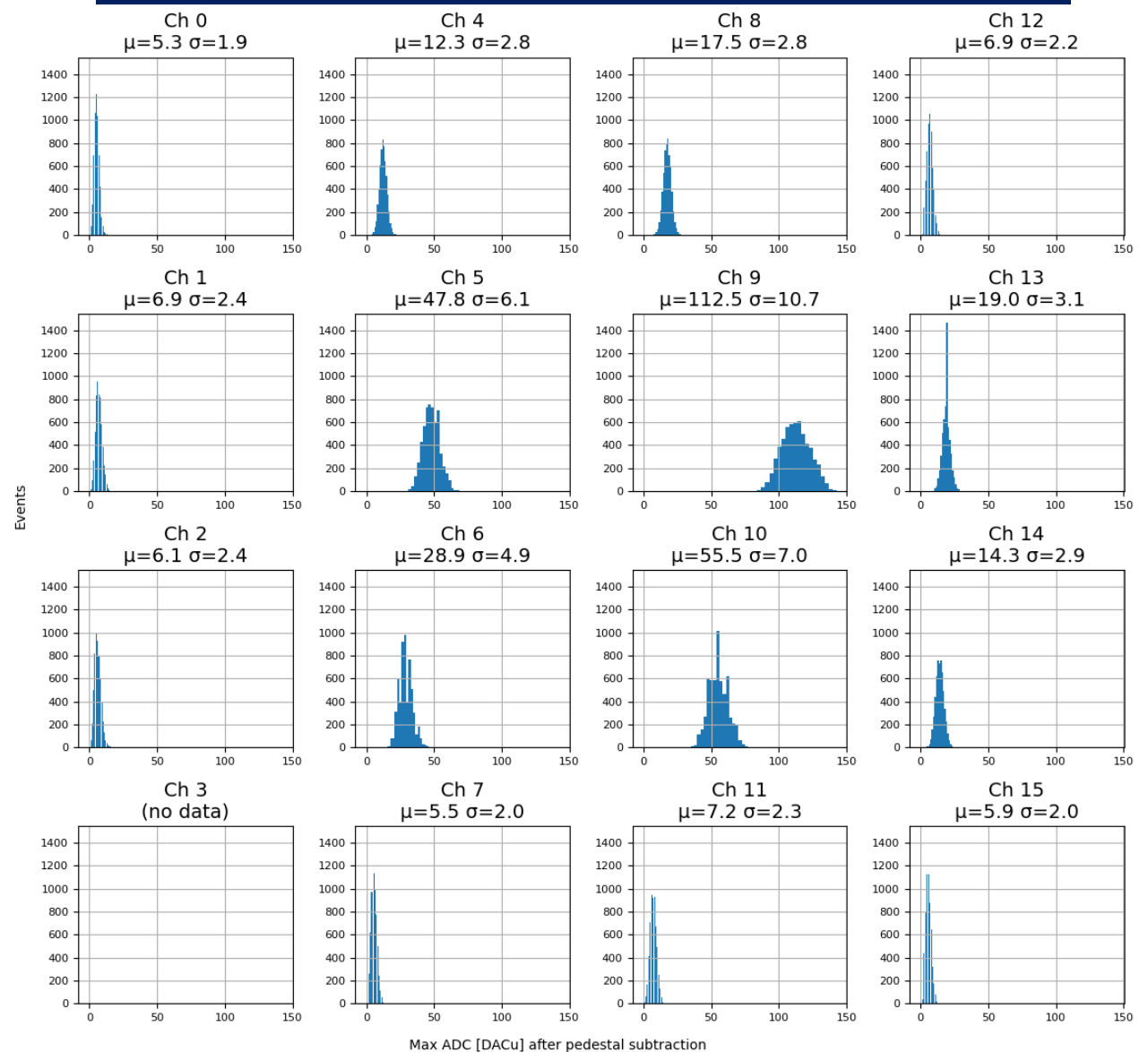
Vth = 500 DACu

Pixel / Channel Mapping	Column 0	Column 1	Column 2	Column 3
Line 0	Pixel (0,0) #00	Pixel (1,0) #04	Pixel (2,0) #08	Pixel (3,0) #12
Line 1	Pixel (0,1) #01	Pixel (1,1) #05	Pixel (2,1) #09	Pixel (3,1) #13
Line 2	Pixel (0,2) #02	Pixel (1,2) #06	Pixel (2,2) #10	Pixel (3,2) #14
Line 3	Pixel (0,3) #03	Pixel (1,3) #07	Pixel (2,3) #11	Pixel (3,3) #15

RAW ADC WAVEFORMS**ADC WAVEFORMS
After pedestal subtraction (evt/evt) from channel 3**

AC-LGAD biased at -158 V
 IR laser att 85%, 1 kHz
 « Auto-trigger » mode
 Vth = 500 DACu

Max ADC [DACu] distributions After pedestal subtraction (evt/evt) from channel 0



Pixel / Channel Mapping	Column 0	Column 1	Column 2	Column 3
Line 0	Pixel (0,0) #00	Pixel (1,0) #04	Pixel (2,0) #08	Pixel (3,0) #12
Line 1	Pixel (0,1) #01	Pixel (1,1) #05	Pixel (2,1) #09	Pixel (3,1) #13
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Line 3	Pixel (0,3) #03	Pixel (1,3) #07	Pixel (2,3) #11	Pixel (3,3) #15

AC-LGAD biased at -158 V

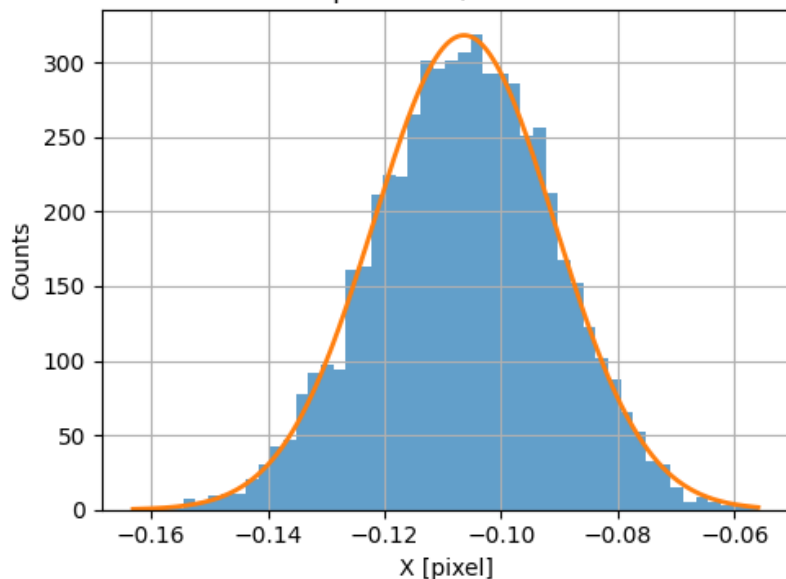
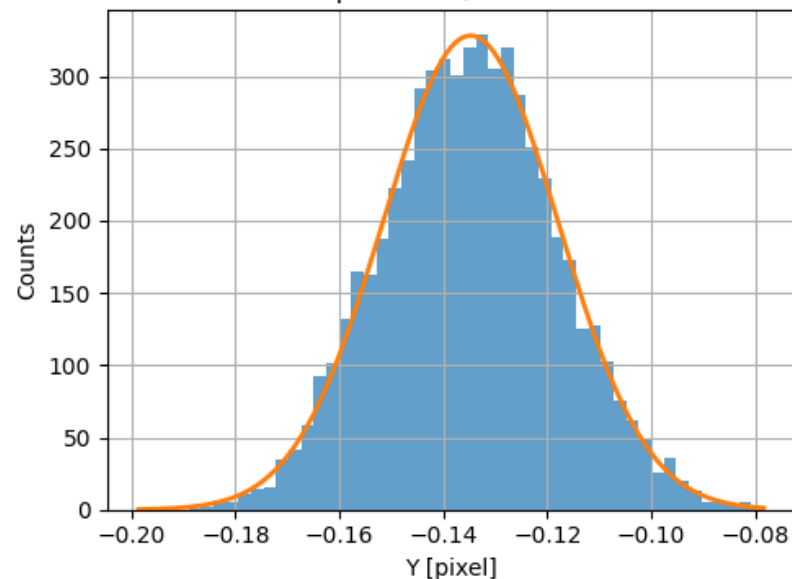
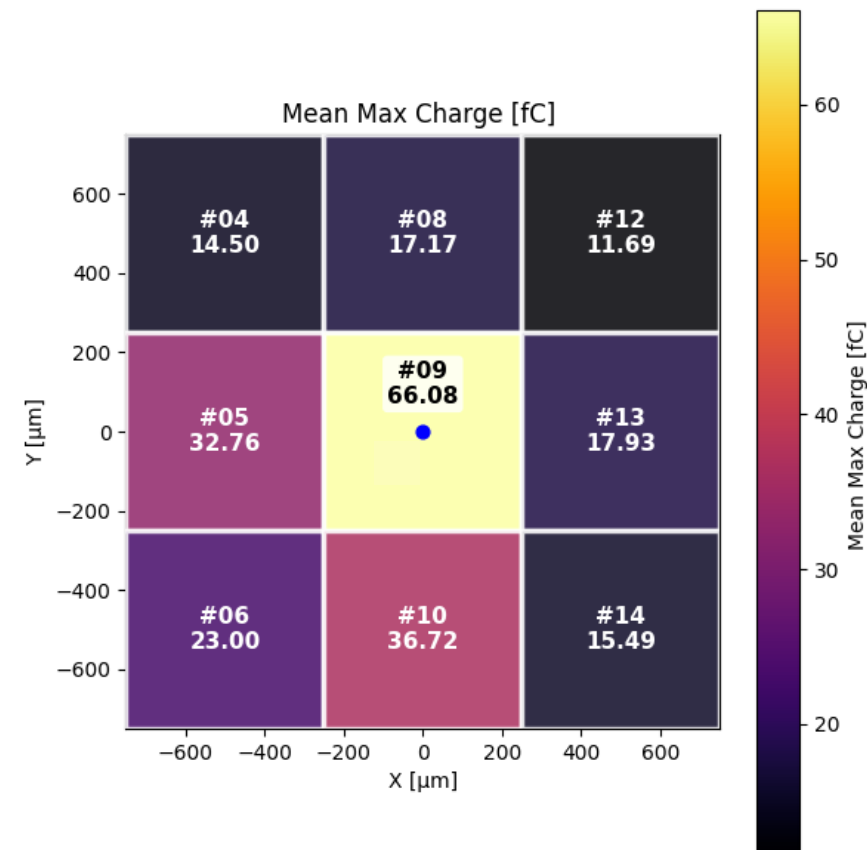
IR laser att 85%, 1 kHz

« Auto-trigger » mode

Vth = 500 DACu

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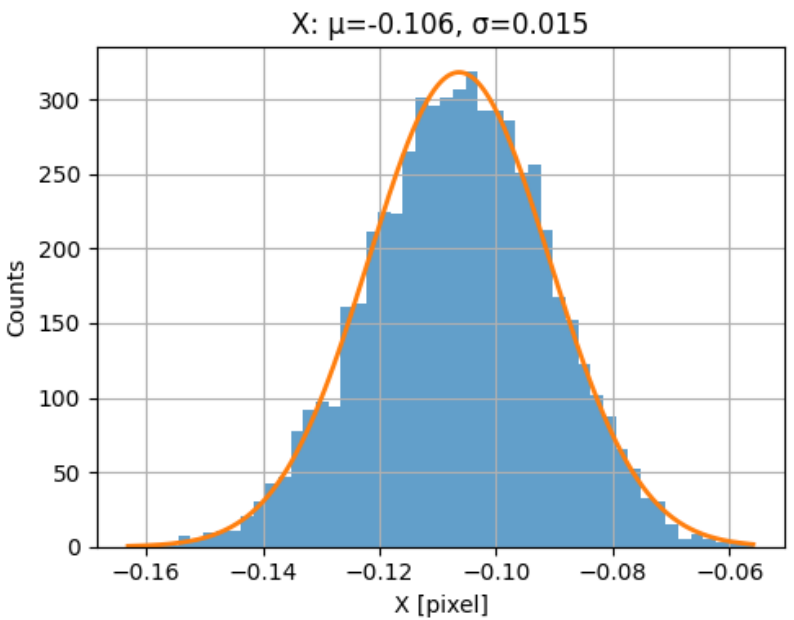
X and Y reconstructed distributions from barycenter After pedestal subtraction (evt/evt) from channel 0

X: $\mu=-0.106$, $\sigma=0.015$ X: Mean = - 53 +/- 8 μm Y: $\mu=-0.135$, $\sigma=0.017$ Y: Mean = - 68 +/- 9 μm 

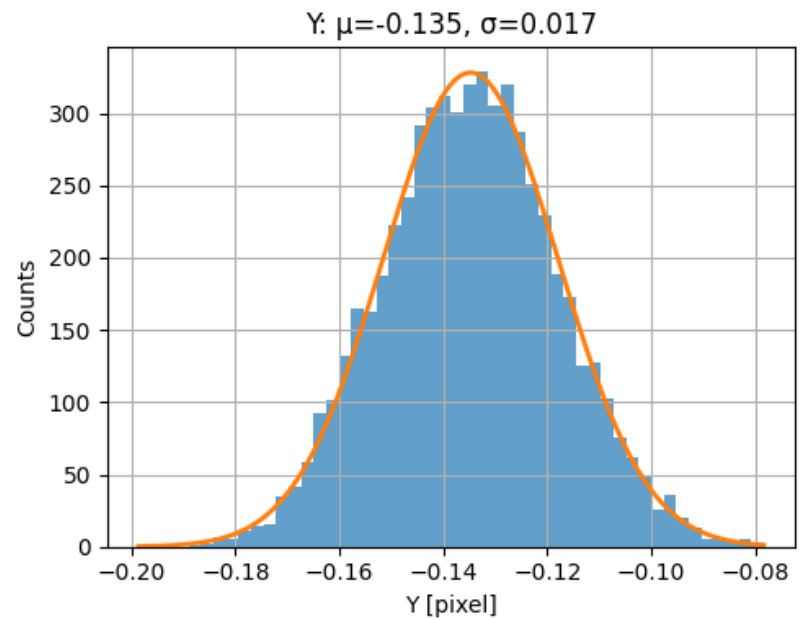
AC-LGAD biased at -158 V
 IR laser att 85%, 1 kHz
 « Auto-trigger » mode
 Vth = 500 DACu

Pixel / Channel Mapping	Column 0	Column 1	Column 2	Column 3
Line 0	Pixel (0,0) #00	Pixel (1,0) #04	Pixel (2,0) #08	Pixel (3,0) #12
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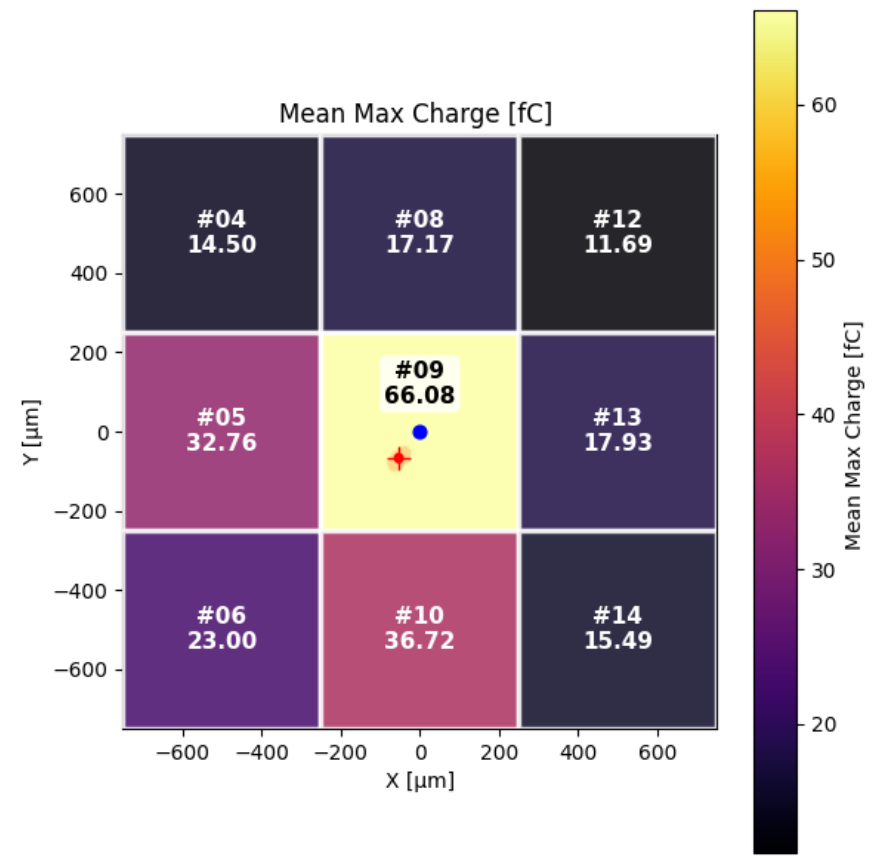
X and Y reconstructed distributions from barycenter
After pedestal subtraction (evt/evt) from channel 3



X: Mean = - 53 +/- 8 μm



Y: Mean = - 68 +/- 9 μm



AC-LGAD biased at -158 V

IR laser att 85%, 1 kHz

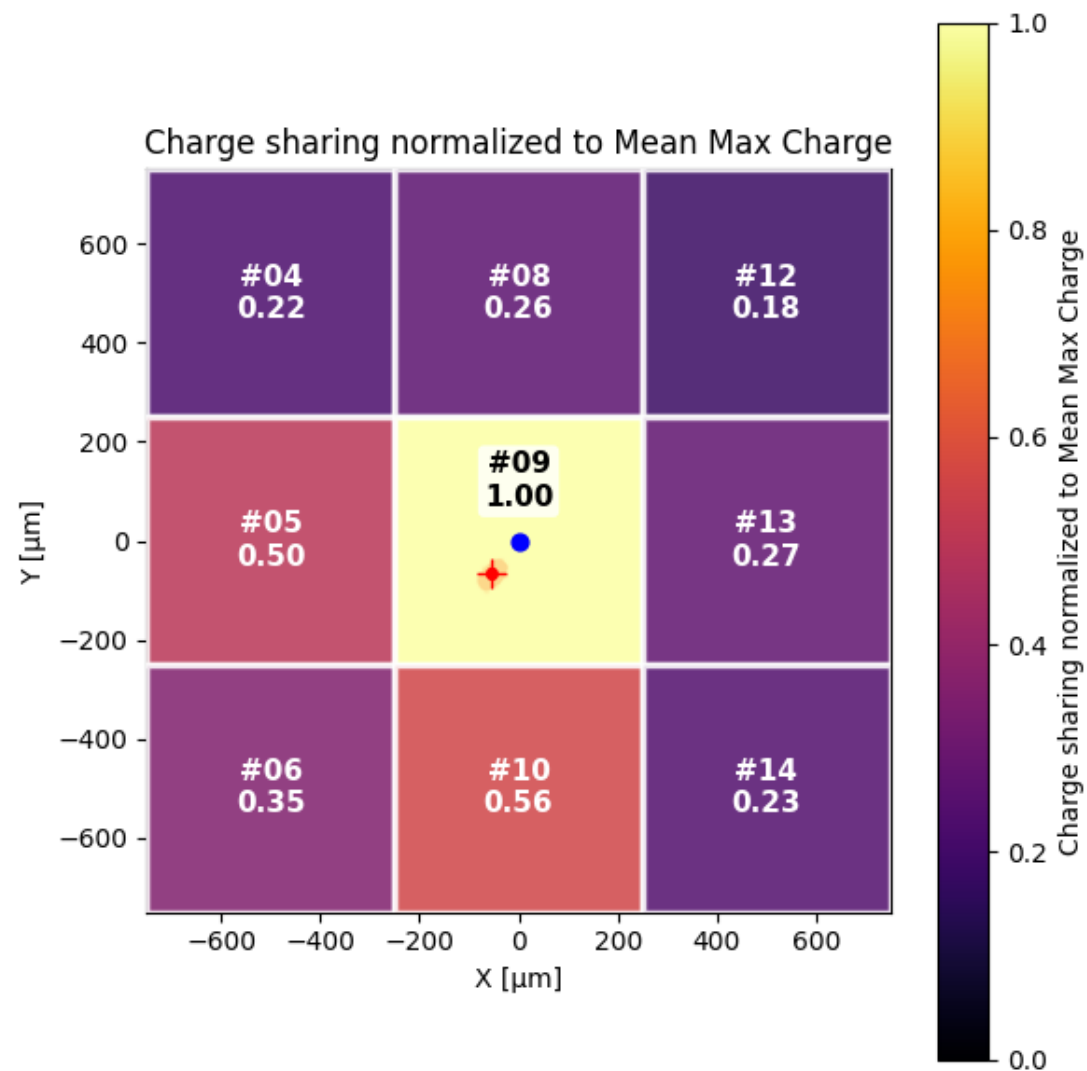
« Auto-trigger » mode

Vth = 500 DACu

10 000 evts

Charge sharing ratio
After pedestal subtraction (evt/evt) from channel 0

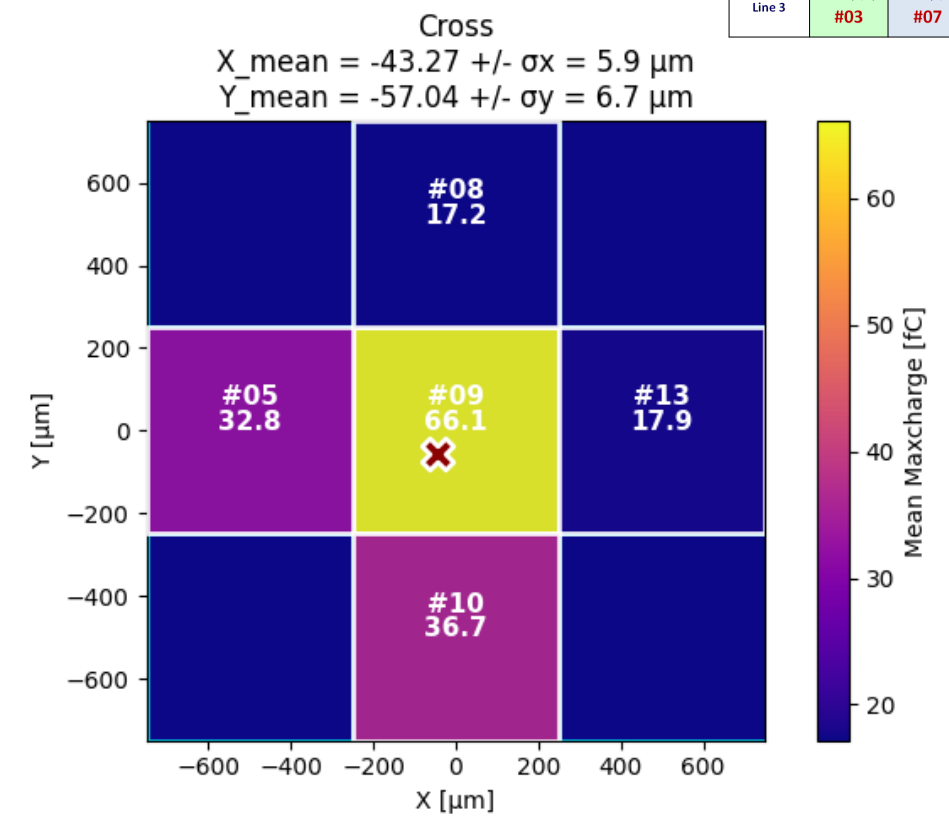
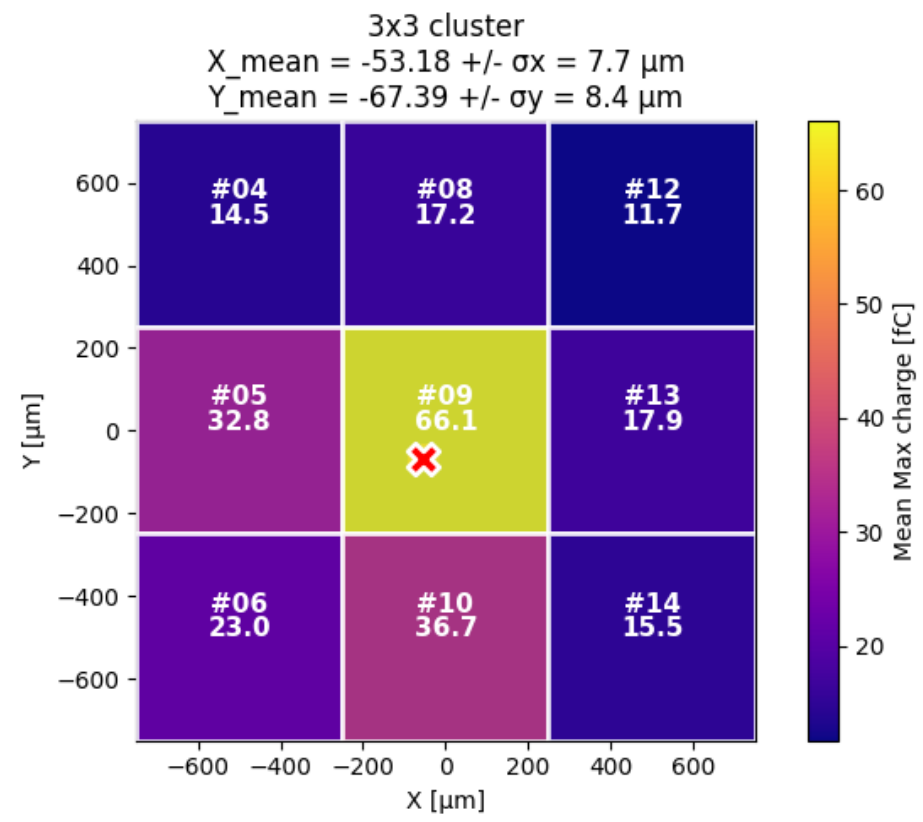
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AC-LGAD biased at -158 V
IR laser att 85%, 1 kHz
« Auto-trigger » mode
Vth = 500 DACu

Comparison betw. Cluster & cross

Pixel / Channel Mapping	Column 0	Column 1	Column 2	Column 3
Line 0	Pixel (0,0) #00	Pixel (1,0) #04	Pixel (2,0) #08	Pixel (3,0) #12
Line 1	Pixel (0,1) #01	Pixel (1,1) #05	Pixel (2,1) #09	Pixel (3,1) #13
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AC-LGAD biased at -158 V

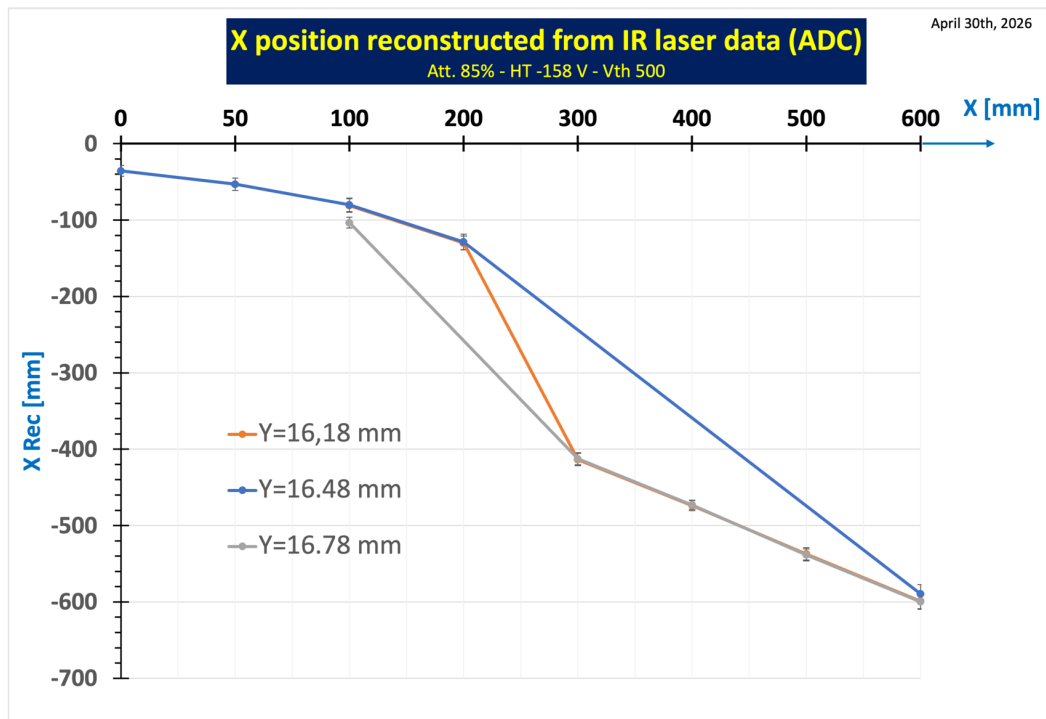
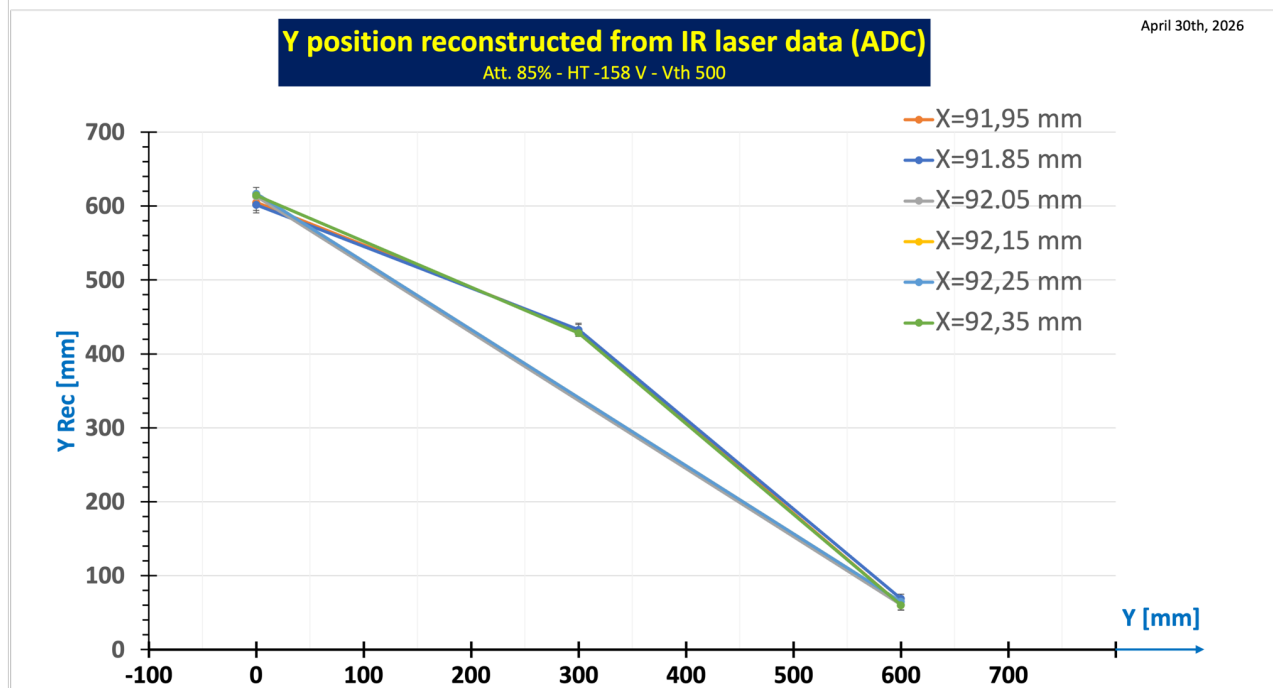
IR laser att 85%, 1 kHz

« Auto-trigger » mode

Vth = 500 DACu

X & Y absolute position reconstructed from 3x3 cluster

Pixel / Channel Mapping	Column 0	Column 1	Column 2	Column 3
Line 0	Pixel (0,0) #00	Pixel (1,0) #04	Pixel (2,0) #08	Pixel (3,0) #12
Line 1	Pixel (0,1) #01	Pixel (1,1) #05	Pixel (2,1) #09	Pixel (3,1) #13
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X: Absoute resolution = 52 +/- 15 μ mY: Absoute resolution = 54 +/- 11 μ m

Conclusion & Outlook

❖ EICROC0: 1st prototype (4x4) channels.

Testing still on-going → Couplings observed ⇒ aimed to drive next iterations

→ TDC jitter & position resolution already fulfillings Roman Pots specification

✓ Development for 3D automatic scan **finalized**

➡ Ready to perform exhaustive testing

✗ Some wire-bonds on sensor **found damaged**

Will exploit a testboard with an HPK sensor waiting for wire-bonding fix

❖ EICROC0A/B/1 now under test at OMEGA

➤ EICROC2 (digital on top) design well under way at LPCA (Clermont-Ferrand, France)